Colloidal dynamics in a glass forming solvent at low temperatures

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We have measured the dynamics of colloidal nano-particles in a glass forming solvent by means of X-ray photon correlation spectroscopy (XPCS). In order to follow the dynamics close to the temperature induced glass transition, we have used a mini cryostat allowing temperatures down to 80K with a very high stability (~0.01 K).
Our measurements have been performed on a dilute suspension of silica particles (D=0.5 micron) in propanediol, a liquid that goes trough a glass transition at T_g =170K. By using the Medipix detector, a 2-D pixelated detector with a full frame rate up to 30 Hz, it has been possible to quantify the dynamics in the temperature range 240K-205K.
Interestingly, though the solvent is still far from the glassy state, our data clearly show that the colloidal dynamics change around T =215K (figure 1 and 2). At "high" temperatures the particle dynamics is Brownian, with a dispersion relation Γ proportional to Q^2 and simple exponential decay of the correlation functions. By decreasing the temperature, we obtain compressed exponential correlation functions (γ>1) and simultaneously, a gradual change occurs in the power-law of the dispersion with an exponent approaching ~1 at T=205 K.
Measurements on suspensions with higher volume fraction suggest that the dynamics below ~215K is collective and our results can be explained by a transition from continuous to intermittent dynamics, probably driven by stress relaxations of the solvent [1].

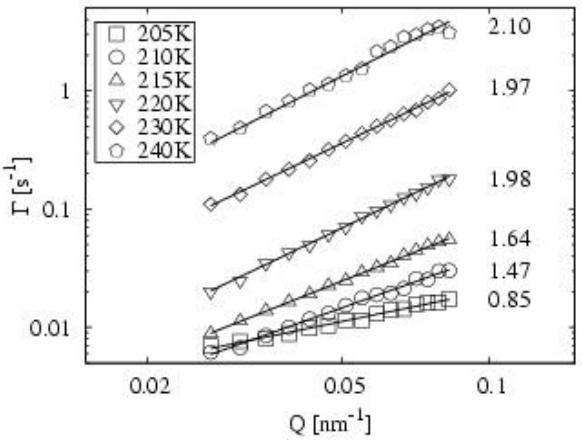

Figure 1 Dispersion relation at various temperatures. Lines are guide to the eye

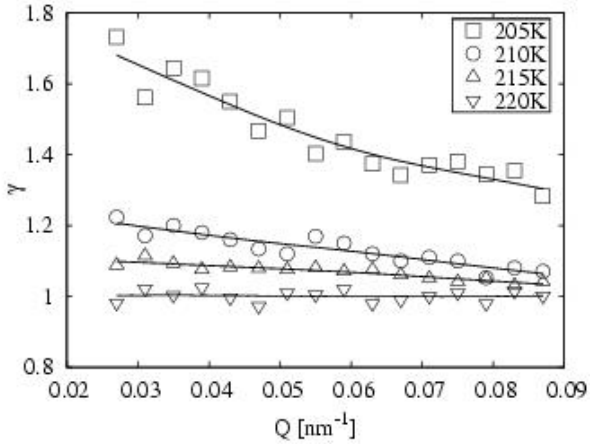

Figure 2 Compressing exponent vs Q at various temperatures. Lines are guide to the eye

[1] Duri A. and Cipelletti L., Europhysics Letters **76**(5) 972, 2006